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Drum Reconditioning Process Optimization

Touhill, Shuckrow and Associates, Inc.
Pittsburgh, PA

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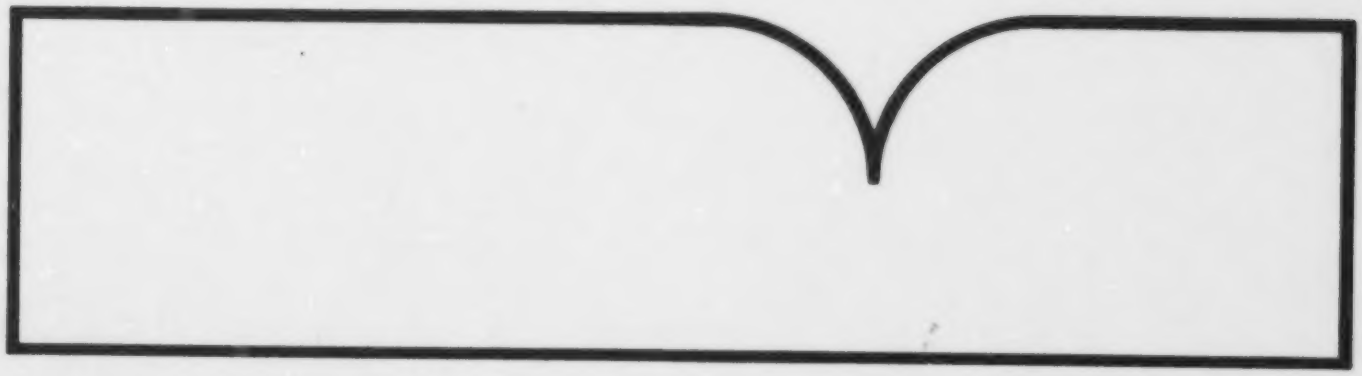

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DRUM RECONDITIONING PROCESS OPTIMIZATION

by

C. J. Touhill
Touhill, Shuckrow and Associates, Inc.
Pittsburgh, Pennsylvania 15237

Contract No. 68-03-2905

Project Officer

Stephen C. James
Solid and Hazardous Waste Research Division
Municipal Environmental Research Laboratory
Cincinnati, Ohio 45268

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

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This report completes a three-part EPA program to assess barrel and drum reconditioning processes. The intent of the report is to provide recommendations for upgrading and optimizing drum reconditioning processes to enable facilities to meet rigorous environmental standards.

Data are summarized for a sampling and analysis test program conducted at three drum reconditioning plants. Collected data are compared with typical pollutant concentrations reported for the industry. Sampling and analysis results are used to assess the potential environmental impact of reconditioning operations in terms of current regulations for air, water, and solid waste pollution control.

Pollution control needs of the industry are evaluated, and methods for upgrading and optimizing current industry practice are recommended. These recommendations specifically relate to identified pollutant pathways. In addition, research needs are identified for pollution control processes and procedures requiring additional effort before they can be used with confidence.

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FOREWORD

The Environmental Protection Agency was created because of increasing concern by the public and government about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development - that necessary first step in solving a problem - involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems to preserve and treat public drinking water supplies, to minimize the adverse economic, social, health, and aesthetic effects of pollution and to prevent, treat, and manage waste water and solid and hazardous waste pollutant discharges from municipal and community sources. This publication is one of the products of that research; it is a vital communication link between the researcher and the community.

Results from a sampling and analysis program at three drum reconditioning plants are presented. These results are the basis for an assessment of the potential environmental impact from the drum reconditioning industry. Recommendations for upgrading and optimizing drum reconditioning processes to enable facilities to meet rigorous environmental standards are discussed.

Francis T. Mayo, Director
Municipal Environmental Research
Laboratory

ABSTRACT

This report completes a three-part Environmental Protection Agency program to assess barrel and drum reconditioning processes. The intent of the report is to provide recommendations for upgrading and optimizing drum reconditioning processes to enable facilities to meet rigorous environmental standards.

Data are summarized for a sampling and analysis test program conducted at three drum reconditioning plants. Collected data are compared with typical pollutant concentrations reported for the industry. Sampling and analysis results are used to assess the potential environmental impact of reconditioning operations in terms of current regulations for air, water, and solid waste pollution control.

Pollution control needs of the industry are evaluated, and methods for upgrading and optimizing current industry practice are recommended. These recommendations specifically relate to identified pollutant pathways. In addition, research needs are identified for pollution control processes and procedures requiring additional effort before they can be used with confidence.

This report was submitted in partial fulfillment of Contract No. 68-03-2905 by Touhill, Shuckrow and Associates, Inc. under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period October 13, 1980, to May 5, 1981. Work on this portion of the contract was completed as of May 5, 1981.

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Finally, special thanks are extended to Mr. Stephen C. James, EPA Project Officer, for his able and interested direction. His continued assistance substantially helped to insure project success.

SECTION 1

INTRODUCTION

PROJECT OBJECTIVES

This report completes the final phase of a three-part Environmental Protection Agency program to assess barrel and drum reconditioning processes. In the first phase, representative practices for barrel and drum burning and washing were defined. Results of that effort were reported in the document entitled, "Barrel and Drum Reconditioning Industry Status Profile" (1). The second phase of the program involved sampling and analysis of three reconditioning plants in order to define pollutant levels in various waste streams. The third and final phase, which is the subject of this report, is intended to provide recommendations for upgrading and optimizing drum reconditioning processes to enable facilities to meet rigorous environmental standards.

Facility optimization may be achieved either through application of new or revised operating procedures, or use of pollution control and treatment processes. This report deals with both options. Wherever possible, specific recommendations for optimization are made. It is believed that if the recommendations within this report are followed by reconditioners, most pollution control criteria and standards should be achieved. Just as these standards continue to evolve (particularly for pretreatment and solid residues), it is expected that optimization likewise will evolve beyond the scope of this report. However, the results of this program form a sound basis for reconditioners to operate in a manner which is both cost-effective and protects the environment.

APPROACH

The report is divided into five major sections. The following section summarizes information presented in the report and provides major recommendations on drum reconditioning process optimization. Section 3 presents data from the sampling and analysis program conducted at three drum reconditioning plants, compares collected data with typical pollutant concentrations reported for the industry, and assesses the potential environmental impact of reconditioning operations.

In Section 4, Pollution Control Needs and Optimization Methods, pollution control needs of the reconditioning industry are evaluated, and methods for upgrading and optimizing current practice are recommended based upon data discussed in the previous section. Some optimization methods presently are used at exemplary plants, while others are derived from applications in other industries.

Finally, in Section 5, optimization needs which require additional research and development before the procedures or processes can be applied with confidence by reconditioners are defined.

SECTION 2

SUMMARY AND RECOMMENDATIONS

This report is the final phase of a three-part Environmental Protection Agency program to assess barrel and drum reconditioning processes. It provides recommendations for upgrading and optimizing drum reconditioning processes to enable facilities to meet rigorous environmental standards.

The environmental assessment section of the report summarizes data from a sampling and analysis test program conducted at three drum reconditioning plants; compares the collected data with typical pollutant concentrations reported for the industry; and assesses the potential environmental impact of reconditioning operations (based upon the sampling and analysis results) in terms of current pollution control regulations.

The three facilities selected for testing were: 1) a large drum washing plant which recycles most of its caustic washing and rinsing solutions (Plant "A"); 2) a large burning and washing plant which is representative of typical practice (Plant "B"); and 3) a large washing plant which handles substantial volumes of pesticide containers (Plant "C").

In general, five classes of parameters were measured at the three plants for various waste streams (pollutant pathways). These were: chemical oxygen demand (COD), organic compounds (including priority pollutants, oil and grease, and phenols), trace metals, particulates, and pesticides. Table 1 indicates the parameters measured and the waste streams sampled. Results of the analyses are given in the body of the report.

Generally, results of the sampling and analysis program confirmed typical ranges of pollutants found in previous evaluations of the industry. Two exceptions were:

1) Higher concentrations of organic compounds, particularly priority pollutants, were evident in aqueous waste streams.

2) Lower metals concentrations, for most elements, were found in aqueous waste streams.

TABLE 1. PARAMETERS MEASURED AND WASTE STREAMS SAMPLED

Waste Stream	Chemical Oxygen Demand			Organic Compounds			Trace Metals			Particulates	Pesticides
	Plant A	Plant B	Plant C	Plant A	Plant B	Plant C	Plant A	Plant B	Plant C	Plant B	Plant C
Spent Caustic Tank Influent	X	X	X				X				X
Spent Caustic Tank Effluent	X	X					X				
Caustic Clarifier Effluent	X	X		X	X						
Flushomatic Caustic Tank	X										
Flushomatic Rinse Tank	X										
Rinse Water Clarifier Effluent	X										
Dissolved Air Flotation Influent	X										
Stormwater Runoff	X	X									
Yard Standing Water	X										
Leak Tester Water	X										
Spent Caustic Holding Tank		X	X				X				
Spent Caustic Sludge				X	X		X		X*		X*
Vent Emissions					X						
Incinerator Emissions					X			X		X	
Incinerator Ash					X			X			
Quench Water					X						

* Dried Sludge

Based upon regulatory standards, results of the sampling and analysis test program indicated the following probable methods of pollutant control for the principal waste streams of concern:

1) Incinerator particulate emissions - operational controls and/or wet scrubbers

2) Incinerator organic emissions - operational controls and/or wet scrubbers

3) Incinerator metals emissions - operational controls and/or wet scrubbers

4) Painting and drying booths - operational controls

5) Caustic washing solutions - treatment and reuse

6) Rinse water - treatment and reuse

7) Quench water - treatment and reuse or mixing with other liquid streams

8) Stormwater runoff - housekeeping, drainage control, treatment, and direct discharge

9) Leak tester water - discharge to public sewers

10) Incinerator ash - landfill (secured)

11) Caustic sludge - treatment and either incineration or landfill (conventional or secured).

12) Drum drainage - treatment and either incineration or landfill (conventional or secured).

This report evaluates pollution control needs and recommended methods for upgrading and optimizing current industry practice. It was determined that implementation of regulations promulgated in conjunction with the Resource Conservation and Recovery Act (RCRA) could have a positive impact upon drum reconditioners under the following circumstances: 1) if the industry refuses to accept drums that formerly contained materials listed by name in 40 CFR 261.33(e) that have not been triple-rinsed by an appropriate solvent; 2) if the industry refuses to accept drums containing residues of hazardous wastes (other than 261.33(e) materials) in quantities greater than 1 inch; and 3) if reconditioners avoid storing accumulated sludge or containers of hazardous wastes for more than 90 days, and if this sludge or containers are not burned, buried, or treated at the reconditioning site.

Listed below are specific recommendations for upgrading and optimizing pollution control at drum reconditioning plants.

Operational and Management Procedures

1) Receiving
   - Refuse to accept the following types of drums
     - damaged drums
     - drums which contain more than 1 inch of residue unless special provision is made to deal with those materials
     - drums which contain unacceptable materials, i.e. those containing hazardous materials and/or materials which the reconditioners customarily refuse (pesticides, resins, inks, adhesives, etc.).
     - drums without bungs, and rings and lids in-place
   - Segregate drums known to create possible smoking problems in order to mix into the normal processing line

2) Storage
   - Store all drums with bungs in-place, and rings and lids on
   - Use "first-in, first-out" inventory methods
   - Provide methods for minimizing stormwater contact with drums

3) Draining
   - Do not drain drums bound for burning
   - Drain empty oil drums, keeping the recovery pit clean
   - Drain other drums bound for caustic washing

4) Waste Stream Segregation
   - Segregate caustic solutions and rinse waters
   - Segregate leak tester and quench water

5) Water Conservation
   - Cascade water use for successive lower quality needs
   - Maintain minimum flows for rinsing, leak testing, cleanup, boilers, and compressor cooling
   - Mop up spills rather than flush to floor drains

6) Housekeeping
   - Pay close attention to housekeeping practices

7) Waste Heat Utilization
   - Use heat exchangers to generate steam for plant heating and caustic washing solution heating
   - Use waste heat to dry wet drums
   - Use waste heat in paint baking ovens

- Use waste heat to preheat drums to assist in draining

Pesticide Container Processing

1) All drums formerly containing pesticides should be triple-rinsed before acceptance.

2) When large numbers of pesticide containers are processed, they should be stored in a separate area, and processed together on a campaign basis.

3) Reconditioners who are not equipped to process pesticide containers should refuse to accept them.

4) Organometallic-type pesticides are not amenable to treatment by either incineration or caustic washing; therefore, containers of such pesticides should be refused in all circumstances.

5) Halogen-containing pesticides are best handled by incineration. (Wet scrubbers using NaOH as the scrubbing liquid should be considered for incinerator emission control.) Such containers should be refused at washing plants.

6) Only drums formerly containing organophosphorus and nitrogen-containing (carbamates) pesticides should be accepted by washing plants with demonstrated expertise in washing such containers.

7) There should be absolutely no pesticide container processing where mixing with drums for food use is possible.

8) The following management and operational procedures should be employed at plants capable of handling pesticide containers:

   - All pesticide drums should be stored in separate designated areas
   - All pesticide drums should be processed separately from other drums
   - All pesticide drums should be received, transported, and stored with bungs in-place
   - Pesticide container processing must be closely supervised
   - Employees should be required to wear respiratory masks and protective clothing when handling or processing pesticide drums
   - Personnel cleanup should be enforced before breaks, lunch, or leaving the plant area

- Regular health examinations should be performed and safety procedures rigorously enforced.

Air Emissions

1) Reconditioners should operate plants in accordance with the National Barrel and Drum Association (NABADA) document, "Drum Reclamation Furnaces: Standards of Design and Operation", December 31, 1979 (3).

2) Incinerator temperatures should be maintained at least at 1200°F.

3) Minimum residence time in the incinerator should be 4 minutes.

4) Afterburner temperatures should be maintained at greater than 1400°F, with a minimum residence time of 0.5 seconds.

5) Afterburners should operate whenever there is danger of particulate or uncombusted organic emissions.

6) In the event that there is danger of higher than normal amounts of combustibles being introduced into the incinerator, the following controls are possible:

   a) varying conveyor speed
   b) varying drum spacing
   c) interspersing drums having large quantities of combustibles with those containing little or no combustibles.

7) Afterburner temperatures for plants burning pesticide containers should be at least 1650°F. Residence times should be a minimum of 0.5 seconds.

8) If particulate and organic emissions exceed air pollution control regulations for normal operation, the afterburner temperatures should be increased to the 1650°F range.

9) If particulates, organics, or trace metal emissions constitute a regulatory problem, then wet scrubbers should be used after the afterburner.

It is believed that adherence to the recommendations above will permit drum incinerators to operate within existing air pollution control standards. Thus, reconditioners should be able to meet air pollution control regulations through careful operations and controls.

Because hydrocarbon emissions from painting and drying booths could be a substantial problem for reconditioners, several operational controls may be implemented to alleviate the problem. Some of these are:

1) increased use of water-based paint

2) use of air-dry paint to reduce evolution of hydrocarbons

3) use electrostatic spraying techniques to reduce the amount of paint

4) use high solids paints.

Liquid Waste Streams

1) All waste streams, i.e. caustic washing solutions, rinse water, leak tester water, and quench water, should be kept segregated, and treated separately for discharge and reuse.

2) Phase separation (flotation of oil and grease, and solid settling) of caustic washing solutions is the minimum level of treatment recommended before recycle.

3) Filtration of caustic solutions after phase separation is highly desirable.

4) Pilot-scale feasibility studies on the treatment of rinse waters using ultrafiltration is recommended.

5) Treated rinse water should be used to make up losses in caustic solutions.

6) Quench water volumes (used to cool drums at the furnace) should be reduced by using quenching only when necessary, and by using fine water mist sprays.

7) The source of quench water should be treated rinse water.

8) Collected quench water should be sent to the rinse water treatment system for processing.

9) Leak tester water may be discharged directly to the sanitary sewer system.

10) For stormwater runoff:

- Enforce good housekeeping in the drum storage area

- Store all drums with bungs and rings and lids in-place
- Grade the drum storage area so stormwater runs off and does not accumulate near drums or sludge containers
- Do not store drums containing sludges without heads on
- Do not place solid residues or sludges on the ground
- Store sludges which are not in drums in separate large covered containers
- Place berms and dikes around the drum storage area

11) When measures cited above for stormwater runoff are insufficient to meet regulatory standards, use a stormwater holding pond with oil skimming equipment.

Solid Residues

1) Conduct regular tests to determine if solid residues are hazardous (such as the EPA Extraction Procedure (EP) toxicity, corrosivity, reactivity, and ignitability tests).

2) Reduce sludge volumes as much as possible.

3) Until ambiguities in RCRA regulations are resolved, reconditioners should treat all solid residues as hazardous.

4) Alternatives for reducing sludge volumes are:

- Additional settling or phase separation (with or without chemical addition and pH adjustment)
- Vacuum filtration
- Filter press
- Centrifugation
- Heat treatment

5) The recommended approach for caustic sludge disposal is:

- Reduce sludge volume as much as possible through dewatering
- Recover oily wastes for incineration as a supplemental fuel where feasibile
- If the sludge is nonhazardous, then ultimately dispose by conventional landfill or incineration
- If the sludge is hazardous, then ship the wastes to a contract hazardous waste management site

6) If treatment of rinse water using ultrafiltration proves feasible, dispose of sludges by one of the following methods:

   - Mix the ultrafiltration concentrate with tramp oils (recovered free oil) or No. 2 fuel oil and burn directly
   - Settle the concentrate for 3 to 5 days and burn the oil phase; recycle the water phase to the ultrafiltration unit
   - Heat the concentrate to 71°C to 82°C (160°F to 180°F) and acidify to pH of 2; the oil phase may be burned and the water phase is neutralized and recycled to the ultrafiltration unit
   - Use a contract hauler

7) Incinerator ash should be settled in a transportable container with the decanted liquid being sent for treatment to the rinse water processing system, and the ash sent to a hazardous waste facility.

8) Clean recovered oil should be sold to a rerefiner.

9) Hazardous drum drainage should be shipped to a permitted hazardous waste facility.

10) Drum drainage pits should be covered.

11) Nonhazardous drum drainage should be used as a supplemental fuel, if possible.

Research and development needs identified as a result of this program are:

1) Evaluate whether incinerator particulate, trace metal, and organic emissions can be controlled effectively using operational procedures, e.g. rigorous temperature control, elevated temperatures, variable conveyor speeds, drum spacing, and drum mixing.

2) Develop better filtration systems for preparing caustic washing solutions for reuse.

3) Determine the feasibility of ultrafiltration for use in processing rinse water for reuse.

4) Develop a strategy for cascading water uses (from higher to lower quality needs).

5) Evaluate the potential of good housekeeping and drum storage yard management procedures for minimizing contamination of stormwater runoff.

6) Develop better processes for caustic and rinse water sludge dewatering.

7) Evaluate procedures for disposing of nonhazardous sludges and residues, including oily waste recovery, and sludge burning and drying methods.

SECTION 3

ENVIRONMENTAL ASSESSMENT

This section of the report presents data from a sampling and analysis program conducted at three drum reconditioning plants; compares the collected data with typical pollutant concentrations reported for the industry; and assesses the potential environmental impact of reconditioning operations (based upon the sampling and analysis results) in terms of current regulations intended to control air, water, and solid waste pollution.

SAMPLING AND ANALYSIS PROGRAM

The first phase of an EPA program to assess the environmental impact of barrel and drum reconditioning processes was reported upon previously in a document entitled, "Barrel and Drum Reconditioning Industry Status Profile" (1). The status profile was intended to define representative practice for barrel and drum reconditioning by burning and washing. It included an overview of the industry, described reconditioning processes, evaluated pollutant loadings, and described current pollution control practice.

In the second phase of the program, three reconditioning sites were selected for a sampling and analysis test program in order to define more closely pollutant sources and pathways. The test program served two purposes: it confirmed and supplemented data presented in the status profile, and it identified pollution control needs requiring emphasis in the third phase of the EPA program - drum reconditioning process optimization. The three facilities selected for testing were: 1) a large drum washing plant which recycles most of its caustic washing and rinsing solutions; 2) a large burning and washing plant which is representative of typical practice; and 3) a large washing plant which handles substantial volumes of pesticide containers.

For purposes of this report, the drum plant which recycles most of its caustic and rinsing solutions is designated as Plant "A"; the representative burning and washing plant is identified as Plant "B"; and the facility which washes pesticide containers is Plant "C".

Details of the sampling and analysis test program, including

a description of sampling procedures and analytical methods, have been reported separately to EPA. A summary of the results of this effort is provided subsequently in this section. The sampling and analysis was conducted for Touhill, Shuckrow and Associates, Inc. (TSA) by its subcontractor, Monsanto Research Corporation (MRC).

Plant "A" Results

Sampling at Plant "A" was conducted by MRC on July 1 and 2, 1980. Table 2 identifies the samples collected each day and indicates the analysis performed on each sample. Sampling locations corresponding to the sample number are shown on Figure 1. All samples were returned to MRC's Dayton, Ohio, laboratory for analysis.

During the sampling period, 2,400 drums were processed each 8-hour work day. Of the containers processed, 75 percent were empty oil drums, while the remainder formerly contained paint, varnish, acrylics, and various other chemicals. On the first day of sampling, no HCl was available for the acid wash unit, so H_2SO_4 was substituted. On the second day, HCl was used.

Table 3 summarizes results of COD analyses. The sample number in the table lists first the day of sampling with the sample location number following the hyphen. This terminology was used for all subsequent presentations of results.

Composite samples from each of sampling points 1 through 9, and 12 consisted of four equal, measured amounts collected every two hours from 8 a.m. to 2 p.m. on each of two days. All other samples were single grab samples.

Table 4 provides results of trace metals and cyanide analyses. Table 5 summarizes the results of organic analyses, including determination of phenol.

Plant "B" Results

Sampling at the drum washing portion of Plant "B" was performed during the period, August 4-8, 1980. Sampling at the Plant "B" drum incinerator was done on August 21 and 22, 1980. Table 6 indicates sampling locations for the washing part of the plant, as well as the analyses performed.

During the four day sampling period at the washing facility, approximately 1,200 to 1,400 drums per day were processed. About 90 percent were empty oil drums, whereas the remainder formerly contained paints, resins, and various chemicals.

Composite water samples for points 1 through 5 and a grab sample for point 6 were obtained daily. At points 1 through 5,

TABLE 2. IDENTIFICATION OF SAMPLES COLLECTED BY MRC AT PLANT "A," JULY 1-2, 1980

Sampling location	Sample No.	Sample description	Analysis performed
Caustic cleaning system	1	Influent, spent caustic holding tank	COD
	2	Effluent, spent caustic holding tank	COD
	3	Effluent, caustic clarifier	COD, Priority pollutant
	4	Midtank sample, flushomatic caustic tank	COD
	5	Midtank sample, spent caustic holding tank	Metals by AA/ICAP
	6	Midtank sample, rotostrainer tank	Metals by AA/ICAP
	13	Sludge, spent caustic holding tank[b]	Metals by AA/ICAP Organics by GC/MS
Water cleaning system	7	Influent water, outlet of clarified water tank	COD
	8	Effluent water, inlet of dissolved air flotation tank	COD
	9	Midtank sample, flushomatic water tank	COD
Other	10	Ground water (at drum inventory)	COD
	11	Standing water (from stream behind offices)	COD
	12	Leak tester water (from outlet valve)	COD, BOD

[a] Sampling locations corresponding to sample numbers are indicated on Figure 1.

[b] Sample collected July 2 only.

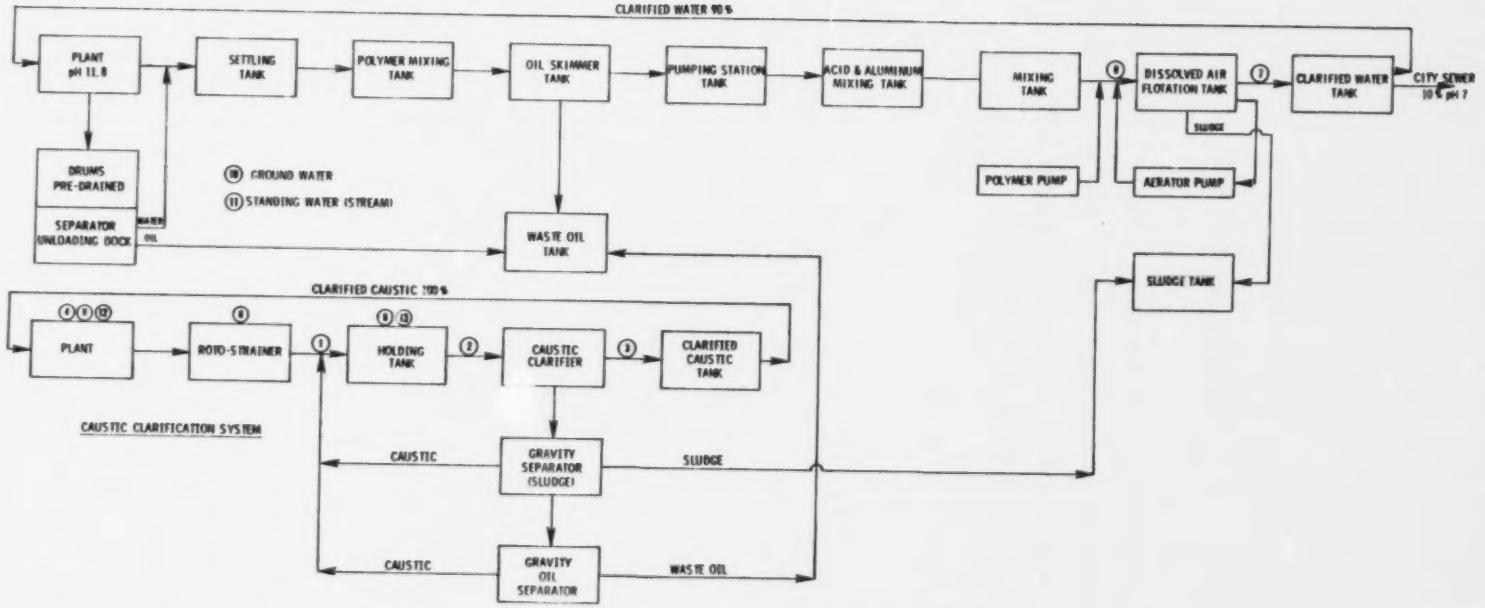

Figure 1. Wastewater treatment and caustic clarification systems for Plant "A." Flow diagram sampling points corresponding to sample identification numbers are indicated.

TABLE 3. COD AND BOD CONCENTRATIONS OBSERVED AT BARREL AND DRUM RECONDITIONING PLANT "A" (mg/L)

	Water stream sampled (sample number)											
	Inlet, clarified water tank		Inlet, dissolved air flotation tank		Flushomatic water tank		Ground water runoff (at drum inventory)		Standing water (stream behind office)		Leak tester (final process)	
	(1-7)	(2-7)	(1-8)	(2-8)	(1-9)	(2-9)	(1-10)	(2-10)	(1-11)	(2-11)	(1-12)	(2-12)
COD	5,880[a]	4,560	1,500[a]	5,740	276,000	46,000[a]	135,000	179,000	246,000	107,000	<50	1,120

	Caustic cleaning system stream sampled (sample number)							
	Influent, spent caustic tank		Effluent, spent caustic tank		Effluent, caustic clarifier		Flushomatic caustic tank	
	(1-1)	(2-1)	(1-2)	(2-2)	(1-3)	(2-3)	(1-4)	(2-4)
COD	94,300[a]	124,000[a]	50,300	14,000[a]	20,700	22,100	264,000	18,300[a]

[a]Average value for two analyses.

TABLE 4. METAL AND INORGANIC[a] CONCENTRATIONS OBSERVED AT BARREL AND DRUM RECONDITIONING PLANT "A" (mg/L)

Metal	Stream sampled (sample number)						
	Caustic clarifier effluent[b] (1-3)	(2-3)	Spent caustic holding tank (1-5)	(2-5)	Roto-strainer tank (1-6)	(2-6)	Spent caustic tank sludge (2-13)
Aluminum	54.1	<0.012	49.5	62.3	59.0	54.2	11.0
Antimony	10.5	4.48	12.4	34.0	32.9	11.5	3.77
Arsenic	0.630	0.494	0.596	2.92	2.56	0.596	0.076
Barium	0.970	0.015	0.350	3.37	3.09	1.79	0.520
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.060
Boron	437	55.3	538	543	848	535	23.1
Cadmium	0.220	<0.002	<0.002	0.110	<0.002	0.200	1.16
Calcium	4.03	14.0	3.46	5.40	4.76	4.13	50.8
Chromium	0.510	<0.004	<0.004	0.240	0.240	0.330	0.880
Cobalt	1.92	0.655	2.51	3.37	2.55	2.95	0.960
Copper	0.480	0.525	<0.006	0.890	0.520	0.500	0.990
Cyanides	4.70	<0.002					
Iron	40.4	32.6	68.4	94.2	86.1	46.1	8.98
Lead	45.4	23.0	43.1	192	227	23.6	4.28
Magnesium	0.010	1.27	0.100	1.83	0.690	<0.001	21.7
Manganese	0.690	<0.001	0.410	7.50	5.26	1.29	1.21
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.178
Molybdenum	9.67	8.81	10.9	18.7	18.9	12.5	3.41
Nickel	7.29	<0.036	2.09	5.86	5.33	7.19	9.48
Phosphorus	179	158	227	262	274	189	36.7
Selenium	0.146[d]	0.037	1.24[d]	0.054[d]	0.087[d]	0.271[d]	0.023
Silicon	0.394[d]	376	0.475[d]	0.486[d]	0.749[d]	0.479[d]	22.9
Silver	0.320	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	6.79[d]	7.96[d]	8.82[d]	11.7[d]	13.4[d]	7.68[d]	2.34[d]
Strontium	0.020	<0.001[e]	<0.002	0.100	0.120	0.070	0.250
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	10.8	4.62	12.7	36.2	39.0	12.4	<0.015
Titanium	0.810	0.335	2.35	2.94	1.90	3.38	0.230
Vanadium	1.41	0.360	1.40	2.34	2.34	1.88	1.41
Zinc	204	2.07	259	377	362	250	1.44

[a] Cyanide is determined in priority pollutant analysis.

[b] Priority pollutant analysis.

[c] Value reported as µg/g.

[d] Value reported as percent.

[e] Average value for two or more analyses.

TABLE 5. ORGANIC COMPOUND[a] CONCENTRATIONS OBSERVED AT BARREL AND DRUM RECONDITIONING PLANT "A," (mg/L)

Organic compound	Stream sampled (sample number)		
	Caustic clarifier effluent Concentration, mg/L		Spent caustic sludge Concentration, mg/kg
	(1-3)	(2-3)	(2-13)
Acenaphthene			7.6
Anthracene	0.2	0.03	
Anthracene/phenanthrene			50
Benzene	<0.01	<0.01	
Chlorobenzene	<0.01	<0.01	
2-Chlorophenol	<0.025	<0.025	14
Chrysene/benzo(a)anthracene			5.4
1,2-Dichlorobenzene	0.02	<0.01	
Dicyclohexylamine			59
2,4-Dimethylphenol	1.25	0.29	
Ethylbenzene	0.05	0.08	
Fluoranthene			5.5
Fluorene			12
Isopropyldiphenyl amine			17
Methylene chloride	0.02	0.01	
Naphthalene	0.2	0.03	47
n-Nitrosodiphenylamine	1.07		1,200
p-chloro-m-cresol	1.52		
Phenol	2.62	0.8	
Phenols, total	18.8	14.2	
Pyrene			5
Tetrachloroethylene	<0.01	<0.01	
Toluene	0.3	0.35	
1,2,4-Trichlorobenzene		<0.01	
1,1,1-Trichloroethane	<0.01	<0.01	

[a]Concentrations are given for all organic priority pollutants detected in the sample. A blank indicates compound was not detected.

TABLE 6. SAMPLING POINTS AT PLANT "B" DRUM WASHING FACILITY, AUGUST 4-8, 1980.

Sampling point	Sample description	Sample numbers	Analyses[a]
At screen filter above spent caustic tank[b]	Influent-spent caustic tank	1-1, 2-1	COD
Waste stream flowing from spent caustic tank to clarifier[c]	Effluent-spent caustic tank	1-2, 2-2	COD
Treated waste stream flowing from clarifier to waste liquid holding tank[c]	Effluent-clarifier	1-3, 2-3	COD non-volatile organics cyanide and phenols
Clarifier sludge outlet	Sludge-suspended in waste liquid[d]	1-4, 2-4	Non-volatile organics
Waste liquid holding tanks[e]	Liquid held for recycle in drum washing facility	1-5, 2-5	COD
Standing water at rear of plant	Water standing above ground	1-6, 2-6	COD
Steam-air vent in roof of washing plant	Porapak filters	SV-1, SV-2, SV-3	Organics

[a] Metal analyses were not able to be completed due to oils in sample collected.

[b] Sample collected from waste stream before passing through filter.

[c] Sample collected by removing grating and dipping from underground waste stream.

[d] Sludge scraped from interior walls of clarifier tank.

[e] Sample collected by dipping from midtank.

four equal measured amounts were collected every two hours from 8 a.m. to 2 p.m. each day. Sample 6 was collected at the end of each day.

Table 7 gives results of COD analyses for caustic solution samples and surface water runoff. An estimated 1,500 gallons of mixed caustic wash and rinse water sludge were produced during the sampling period. Sludges sampled consisted of about ten percent solids suspended in an oil matrix, thus limiting the types of analyses which could be performed. Metal analyses were unable to be performed on sludge and oily waste samples because of the potential for explosions in preparing the samples for metals analysis.

Organic compounds detected in GC/MS screening of sludge and caustic clarifier effluents are presented in Table 8. Also included in the table are results of priority pollutant determinations of total cyanides and total phenols.

On August 4, 1980, samples were obtained from roof vents from the paint and drying booth areas of the reconditioning plant. Resin packed tubes were used to collect these vented emissions. Table 9 shows the results of the organic analyses.

TABLE 9. SUMMARY OF ORGANIC EMISSIONS FROM DRUM RECONDITIONING PLANT "B" VENTS

Organic Compound	Sample Number	Concentrations (mg/m^3) SV-1	SV-2	SV-3
C_2 Benzenes		0.36	0.08	0.09
C_3-C_4 Benzenes		0.59	0.35	0.34
C_7-C_{18} Aliphatics		6.72	0.96	3.87

Sampling for the drum incineration portion of the plant was performed on August 21 and 22, 1980. Particulate analyses were made on samples taken from the incinerator stack subsequent to the afterburner. Table 10 presents results of duplicate particulate runs performed on August 21 and 22, 1980. Front-half particulate is reported as total particulate. The front-half consists of the filter catch and an acetone rinse of the probe. Results are given in both metric and English units.

Organic compound concentrations detected in the drum incinerator stack are reported in Table 11. Note that the value for noncondensible volatile organics are in methane equivalents

TABLE 7. COD CONCENTRATIONS OBSERVED AT BARREL AND DRUM WASHING FACILITY, PLANT "B" AUGUST 4-8, 1980 (in mg/l)

	Stream Sampled (Sample Number)									
	Influent, caustic tank filter		Effluent, spent caustic tank		Effluent caustic clarifier		Waste caustic holding tank		Surface water runoff	
	(1-1)	(2-1)	(1-2)	(2-2)	(1-3)	(2-3)	(1-5)	(2-5)	(1-6)	(2-6)
COD	41,700	386,000	38,600	449,000	514,000	511,000	449,000	498,000	148	106

TABLE 8. ORGANIC COMPOUND AND CYANIDE CONCENTRATIONS OBSERVED AT BARREL AND DRUM RECONDITIONING PLANT "B", AUGUST 4-8, 1980

	Stream sampled (sample number)			
	Concentrations (mg/L)		Concentrations (mg/kg)	
	Caustic clarifier effluent		caustic clarifier sludge	
	(1-3)	(2-3)	(1-4)	(2-4)
Organic Compound				
Acenaphthene	<50	100		
Acenaphthalene			30	300
Acenaphthalenes, C_1			70	200
Acenaphthalenes, C_2			9	40
Aliphatics, C_7-C_{18}	150,000	250,000	13,000	12,000
Anthracene/Phenanthrene	200	500		
Benzenes, C_3-C_4	50,000	74,000	750	2,500
Bis-(2-ethylhexyl)-Phthalate	500	560	20	<5
Chrysene	<50	320		
Diethyl phthalate			20	5
Fluoranthene	70	500		
Naphthalene	1,500	70,000	150	570
Naphthalenes, C_1			120	540
Naphthalenes, C_2			140	530
Phenols, total	340	330		
Pyrene	100	400		
Silicones	200	300	7,000	1,700
Cyanides, Total	2.59	0.915		

TABLE 10. SUMMARY OF PARTICULATE RESULTS FOR INCINERATOR STACK, BARREL AND DRUM RECONDITIONING PLANT "B", AUGUST 21-22, 1980

Date	Run No.	Volumetric flow rate, dry normal m^3/min	Total particulate concentration g/dry normal m^3	Total particulate emission rate, kg/hr	Volumetric flow rate, dry scfm	Total particulate concentration, gr/dry scf	Total particulate emission rate, lb/hr
8-21-80	1[a]	257	0.37	5.63	9,066	0.16	12.40
8-22-80	2[b]	246	0.32	4.69	8,699	0.14	10.34

[a] Run #1 was conducted with afterburner off.

[b] Run #2 was conducted with afterburner on.

(parts per million). In addition, analytical results are for nonvolatile organics in samples from the particulate - organic modified EPA Method 5 sample train (a standard analytical technique).

TABLE 11. ORGANIC COMPOUND CONCENTRATIONS AT DRUM INCINERATOR STACK, PLANT "B"

Organic Compound	Incinerator Stack Emission Rates	
	mg/dnm^3	Kg/hr
C_7-C_{25} Aliphatics	7.423	0.114
C_3-C_4 Benzenes	2.062	0.032
Diethyl phthalate	0.804	0.012
Naphthalene	0.515	0.008
Silicones	4.711	0.073
Noncondensible volatile organics	51[a]	

[a] methane equivalents, expressed as ppm, average value

Table 12 shows metal analysis results for samples from the particulate - trace metal modified Method 5 sample train for incinerator stack emissions. Also included are metals analyses for incinerator ash samples. These samples were obtained from the incinerator ash collection container. Table 13 reports organic compound concentrations in the incinerator ash.

Results of the volatile organics analysis of drum quench water (used to cool hot drums exiting the furnace) are shown in Table 14.

Plant "C" Results

Sampling at Plant "C" was conducted July 21 through 25, 1980. Samples were collected at the four locations identified in Table 15. These locations are shown in Figure 2. No samples were taken at locations 5, 6, and 7.

During the 5-day sampling period, approximately 16,000 drums were processed. On the first day of sampling, 468 pesticide drums were washed. A total of 4,000 drums of all types were processed that day. The pesticide drums contained either parathion, Diazinon, or Nemacur. No pesticide drums were washed during the remaining four days of the sampling period. However, all composite samples were analyzed for pesticides to determine concentrations remaining in the caustic washing solution.

TABLE 12. METAL CONCENTRATIONS OBSERVED AT DRUM INCINERATION FACILITY, PLANT "B" AUGUST 22, 1980

Metal	Incinerator Ash Concentration mg/kg ash	Incinerator Stack Emissions Concentration mg/dncm	Concentration gr/dscf	Emission rate kg/hr	Emission rate lb/hr
Aluminum	9,700	1.397	0.0006	0.021	0.041
*Antimony	105	0.384	0.0002	0.006	0.011
*Arsenic	9.2	0.011	<0.0001	<0.0002	<0.001
Barium	9,460	1.571	0.0007	0.023	0.047
*Beryllium	<2	<0.002	<0.0001	<0.0001	<0.0001
Boron	78.7	1.217	0.0005	0.018	0.036
*Cadimum	11	0.312	0.0001	0.005	0.009
Calcium	7,840	5.063	0.0022	0.075	0.150
*Chromium	1,250	1.835	0.0008	0.027	0.054
Cobalt	24.5	0.434	0.0002	0.006	0.013
*Copper	1,880	1.178	0.0005	0.017	0.035
Iron	5,330	68.132	0.0298	1.006	2.021
*Lead	8,740	15.024	0.0066	0.222	0.446
Magnesium	1,110	1.474	0.0006	0.022	0.064
Manganese	35.9	1.475	0.0006	0.022	0.064
*Mercury	2.8	0.002	<0.0001	<0.0001	<0.0001
Molybdenum	320	1.201	0.0005	0.018	0.036
*Nickel	79.6	13.075	0.0057	0.193	0.388
Phosphorus	606	0.870	0.0004	0.013	0.026
*Selenium	1.0	0.008	<0.0001	<0.0002	<0.001
Silicon	156	0.414	0.0002	0.006	0.012
*Silver	<30	<0.003	<0.0001	<0.001	<0.001
Sodium	1,450	25.494	0.0111	0.376	0.756
Strontium	953	0.178	0.0001	0.003	0.005
*Thallium	<98.0	<0.100	<0.0001	<0.002	<0.003
Tin	199	1.570	0.0007	0.023	0.047
Titanium	426	1.661	0.0007	0.025	0.049
Vanadium	98.3	0.061	<0.0001	<0.001	0.002
*Zinc	700	5.046	0.0022	0.074	0.150

*Priority pollutant metal

TABLE 13. ORGANIC COMPOUND CONCENTRATIONS IN DRUM INCINERATOR ASH, PLANT "B"

Organic Compound	Concentration (mg/kg)
C_7-C_{25} Aliphatics	4,200
Anthracene	40
C_1 Anthracene	30
C_2 Anthracene	50
C_3-C_4 Benzenes	900
Bis(ethylhexyl) phthalate	170
Butyl benzl phthalate	5
Diisobutyrate	100
Fluoranthene	10
Naphthalene	90
C_5 phenol	60
Pyrene	30
Silicones	10

TABLE 14. VOLATILE ORGANIC COMPOUNDS OBSERVED IN DRUM INCINERATOR QUENCH WATER, PLANT "B", August 22, 1980

Organic Compound	Quench Water, WR-2 (mg/l)
Benzene	0.04
Ethylbenzene	0.43
Chloroform	<0.01
Chloroethane	0.01
1,1-Dichloroethane	0.03
1,2-Dichloroethane	<0.01
1,1,1-Trichloroethane	0.47
1,1-Dichloroethylene	0.12
Trichloroethylene	0.01
Tetrachloroethylene	0.01
Toluene	6.39
Methylene Chloride	0.11
Trichlorofluoromethane	<0.01

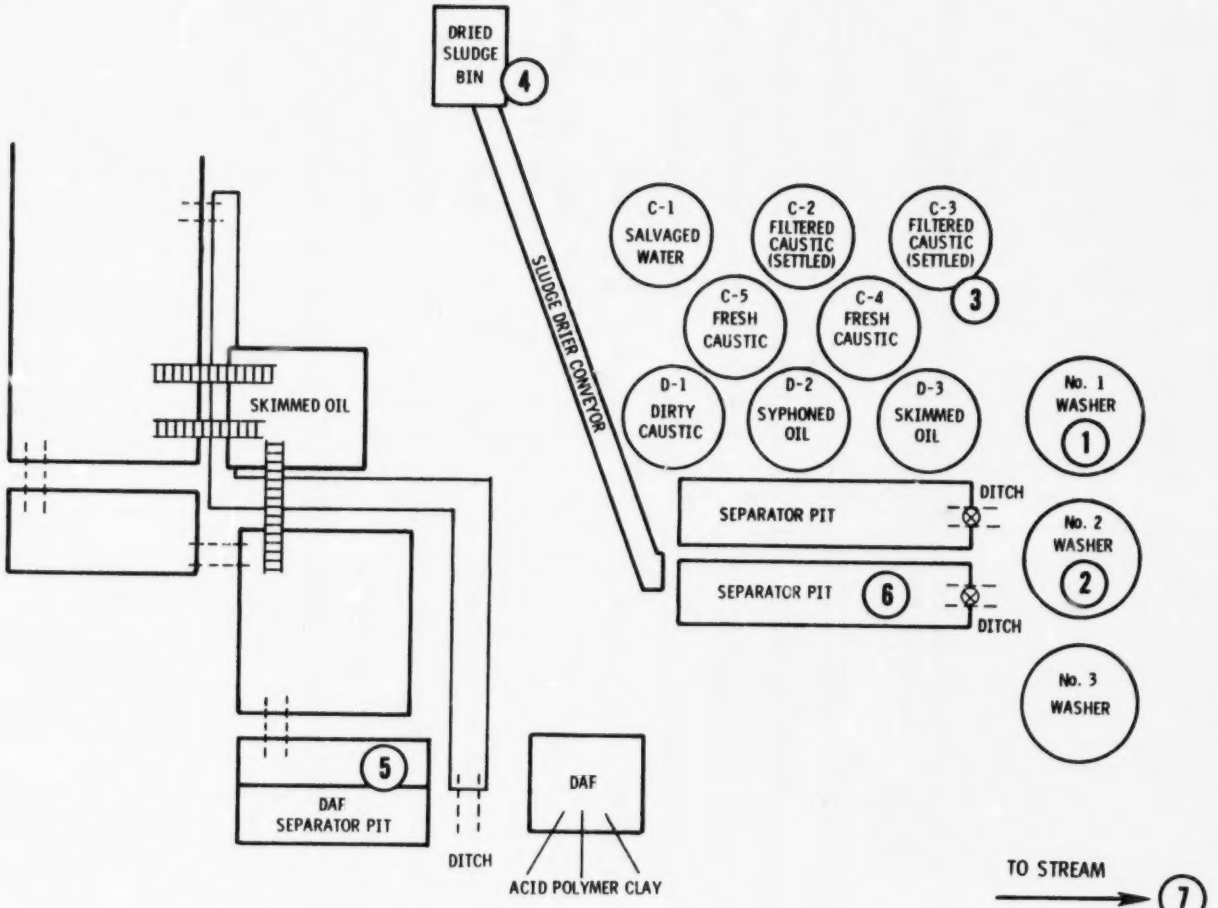

Figure 2. Sampling point locations, July 21-25, 1980.

TABLE 15. IDENTIFICATION OF SAMPLING POINTS WITH CORRESPONDING SAMPLE NUMBERS AND SAMPLE ANALYSES PERFORMED FOR PLANT "C", July 21-25, 1980

Sampling Point	Identification	Sample Numbers	Analysis
1	Caustic washing unit 1	1-1, 2-1, 3-1	Pesticides, COD
2	Caustic washing unit 2	1-2, 2-2, 3-2	Pesticides, COD
3	Filtered caustic tank	1-3, 2-3, 3-3	COD
4	Dried sludge bin	1-4, 2-4, 3-4	Moisture, pesticides, metals

Samples from the caustic solution were collected at the first stage recirculating pump outlet valve from each of the two washing units.

At sampling points 1, 2, and 3, four equal measured amounts were collected every two hours from 9 a.m. to 3 p.m. each day. Single grab samples were obtained from sampling point 4 at the end of each day.

Table 16 shows the organophosphorus pesticide concentrations for each of the two washing units. Also included in the table is an analysis of dried sludge. No pesticides were expected in the sludge because the caustic washing solutions were reused for the duration of the sampling period. Thus, sludge potentially containing pesticides would not be evident. No pesticides were detected as was expected.

Table 17 gives results of COD analyses of caustic washing solutions for the same units and period as for the pesticide analyses.

Grab samples of dried sludge were removed daily from the dried sludge bin at the end of the conveyor sludge drier. In the drier, wet sludge is exposed to jets of hot air as it is conveyed from the separation pits to the sludge bin. Table 18 presents results of moisture and trace metal analyses of sludge samples collected from the dried sludge pit.

Comparison With Other Data

Air Emissions--

TABLE 16. PESTICIDE CONCENTRATIONS OBSERVED AT BARREL AND DRUM RECONDITIONING PLANT "C", JULY 21-25, 1980[a] (μg/mL)[b]

Pesticide	Detection limit[c]	Stream sampled (sample number)							
		Caustic washing unit 1[d]		Caustic washing unit 2			Dried sludge bin		
		(1-1)	(2-1)	(1-2)	(2-2)	(3-2)	(1-4)	(2-4)	(3-4)
Diazinon	1.8	2.3	2.4	0.40	0.43	BDL[e]	BDL	BDL	BDL
Nemacur	1.8	6.5	1.3	BDL	0.25	0.29	BDL	BDL	BDL
Parathion	3.1	3.8	5.9	1.0	0.94	0.52	BDL	BDL	BDL

[a] See Appendix B for analysis procedures.

[b] 1 μg/mL = 1 part per million.

[c] Concentration of each sample before analysis enabled quantification of values below detection limits.

[d] Analysis of two samples from washing unit 1. Sample 3-1 was broken in shipment.

[e] Below detection limits.

TABLE 17. WASTEWATER COD CONCENTRATIONS OBSERVED AT CAUSTIC CLEANING SYSTEM OF BARREL AND DRUM RECONDITIONING PLANT "C", JULY 21-25, 1980

Stream sampled (sample number)	COD, mg/L
Caustic washing unit 1	
(1-1)	59,800
(2-1)	66,700
(3-1)	83,500
Caustic washing unit 2	
(1-2)	29,200
(2-2)	30,500
(3-2)	35,500
Spent caustic holding tank	
(1-3)	22,900

TABLE 18. METAL CONCENTRATIONS OBSERVED AT BARREL AND DRUM RECONDITIONING PLANT "C", JULY 21-25, 1980

	Dried sludge sample number		
	(1-4[a])	(2-4)	(3-4)
Moisture content, weight percent	27.66	14.63	45.20
Metal, mg/kg			
Aluminum	8,500	12,700	7,800
*Antimony	889	975	828
*Arsenic	6.6	11.7[a]	6.8
Barium	3,100	4,900	3,000
*Beryllium	1.94	1.90	<1
Boron	378	539	405
*Cadmium	65.2	95.2	73.6
Calcium	23,000	33,400	22,800
*Chromium	1,500	2,300	1,400
Cobalt	209	548	293
*Copper	990	1,900	919
Iron	81,500	134,000	80,000
*Lead	5,900	10,300	5,800
Magnesium	3,600	6,200	3,800
Manganese	779	1,200	771
*Mercury	3.1	1.7	3.5
Molybdenum	269	202	60.1
*Nickel	1,900	2,100	1,600
Phosphorus	4,200	5,600	4,000
*Selenium	1.0	1.3	1.4
Silicon	1,600	1,600	1,400
*Silver	231	230	198
Sodium	55,600	87,600	58,800
Strontium	127	194	126
*Thallium	<10	<10	<10[a]
Tin	265	320	227
Titanium	1,300	6,800	1,800
Vanadium	290	341	289
*Zinc	1,900	3,300	2,000

[a]Average values for two analyses.

*Priority Pollutant Metal

Incinerator Particulates--An EPA source assessment report (2), which included drum cleaning by incineration, concluded that particulate emissions did not constitute a problem at drum incinerators. Because specific data were not presented in that report, it is presumed that particulate emissions were below regulatory standards at that time. The EPA status profile report of the barrel and drum reconditioning industry (1) cited data from an incinerator stack test. Particulate concentrations (corrected to 12% CO_2) were reported to average 0.102 gr/dry scf for three runs.

At Plant "B", particulate concentrations were 0.16 gr/dry scf and 0.14 gr/dry scf, without and with the afterburner on, respectively. Later in this section, these values will be evaluated in terms of various state particulate emission standards.

Incinerator Organics--The EPA source assessment which included drum cleaning (2) concluded that hydrocarbon vapors were negligible from drum incinerators. In addition, they stated that "emissions from drum burning furnaces can be controlled by maintaining proper operating conditions". No rigorous evaluations of drum incinerators have been reported in terms of organic emissions.

Incinerator Metals--Trace metals emissions from drum incinerators have not been reported upon or discussed elsewhere.

Vent Emissions--Vent emissions from drum painting and drying booths have not been reported upon elsewhere.

Liquid Waste Streams--

Chemical Oxygen Demand--In the industry status profile report (1), chemical oxygen demand (COD) values were obtained from 24 locations. The range of reported concentrations (in mg/l) was from 92 to 311,000. The mean concentration was 24,550 mg/l with a standard deviation of 64,900 mg/l. Because the data were obtained from various size plants and included caustic and rinse water, the variability was expected.

Data summarized for the three plants sampled (Table 19) also show considerable variability, not only between different process operations, but also in terms of daily fluctuations. Review of data in Table 19 leads to the following conclusions:

1) COD is an appropriate analytical measurement to provide a gross indication of the quality of various process solutions and waste streams.

2) Because fresh caustic solution was used at Plant "C" at day 1 of sampling, it is apparent that the COD loading builds quickly, i.e. to nearly 60,000 mg/l. Furthermore, increases in COD are evident as more drums are processed.

TABLE 19. SUMMARY OF CHEMICAL OXYGEN DEMAND (COD) ANALYSES

Waste Stream	Plant	COD (mg/l) Sample 1	Sample 2	Sample 3	Average
Spent Caustic Solution	A	94,300	124,000	-	109,150
	B	41,700	386,000	-	213,850
	C	59,800	66,700	83,500	70,000
	C*	29,200	30,500	35,500	31,730
Spent Caustic Tank Effluent	A	50,300	14,000	-	32,150
	B	38,600	449,000	-	243,800
	C	22,900	-	-	22,900
Caustic Clarifier Effluent	A	20,700	22,100	-	21,400
	B	514,000	511,000	-	512,500
Flushomatic Caustic Tank	A	264,000	18,300	-	141,150
Waste Caustic Holding Tank	B	449,000	498,000	-	473,500
Flushomatic Rinse Tank	A	276,000	46,000	-	161,000
Rinse Water Clarifier Effluent	A	5,880	4,560	-	5,220
Dissolved Air Flotation Tank Influent	A	1,500	5,740	-	3,620
Surface Water Runoff	A	135,000	179,000	-	157,000
	B	148	106	-	127
Ponded Surface Water	A	246,000	107,000	-	176,500
Leak Tester	A	<50	1,120	-	585

* From second series washing unit

Similar results are seen for Plant "A".

3) Caustic solution at Plant "B", on the second day, contained substantial organic materials.

4) Plant "C" uses a second caustic washing step in series. Even though the first caustic wash removes substantial materials, an appreciable amount is removed in the second step.

5) Spent caustic tank effluent data from Plants"A" and "C" indicate that around 70 percent of the COD can be removed by phase separation (i.e. flotation and settling). Phase separation at Plant "B" did not appear to be effective. Based upon observations at Plant "B", and because of the waste handling system which appeared to be overloaded, this was expected.

6) Additional phase separation, beyond that observed in the spent caustic tank, is possible as seen from Plant "A" data.

7) Plant "B" caustic clarifier is ineffective, probably because of overloading.

8) There can be appreciable buildup of organics in caustic holding tanks and reservoirs.

9) The rinse water treatment system at Plant "A" appears to be effective in reducing organic contaminants.

10) High COD concentrations in surface water runoff and ponded water at Plant "A" most likely could be avoided, especially when compared with the values at Plant "B".

11) Leak testing water should be monitored for contamination, particularly if discharged directly to streams.

Organic Pollutants--Data from the industry status profile(1) showed low levels of priority pollutants in drum washing solutions. Data from this sampling and analysis program indicates that priority pollutants do appear in the caustic clarifier effluent; sometimes in substantial quantities. Table 5 gives data for Plant "A", and Table 8 for Plant "B". There are moderate concentrations of specific organic compounds in Plant "A" caustic clarifier effluent, but considerably higher amounts in Plant "B" caustic clarifier effluent. This could be due to differences in the types of drums processed or the way the plants are operated.

Metals--Considerable data on metals concentrations in caustic and rinse waters was presented in the status profile report (1). When compared with the data from the sampling and analysis

program for Plant "A" (Table 4), concentrations for most trace metals were in the range previously reported. However, the following metals were found in concentrations appreciably beyond the maximum values previously observed: antimony, arsenic, boron, cobalt, molybdenum, nickel, and tin. Silicon and phosphorus concentrations also were much higher than seen before, but these are of less concern than the heavy metals. No data for vanadium previously was reported.

Quench Water--Table 14 shows relatively low concentrations of organic compounds in quench water. Previous data, as reported in the industry status profile (1), focused on gross pollutants and metals, some of which were found in high concentrations. It is concluded that these parameters rather than the organics will control treatment needs.

Pesticides--Pesticide concentrations observed in the caustic washing solutions of Plant "C" (Table 14) may be compared with data from the industry status profile (1). In the status profile, it was estimated that caustic washing of drums that formerly contained organophosphorus pesticides would hydrolyze these materials.

Solid Residues--

Caustic Sludge--Table 20 compares metals concentrations found in caustic sludges at Plant "A" with those previously reported in the industry status profile (1). In addition, a column in the table lists for reference the EPA extraction procedure(EP) criteria for hazardous wastes. In every case, except for sodium, the metals found in Plant "A" are substantially lower than those shown in the industry status report.

Table 21 summarizes data on organic compound concentrations found in spent caustic sludges for Plants "A" and "B". No such data has been found elsewhere in previous reviews.

Incinerator Ash--Tables 12 and 13 report metal and organic compound concentrations, respectively, for incinerator ash at Plant "B". No analyses of incinerator ash were available from previous work.

Dried Sludge--Data from the unique sludge drying operation at Plant "C" is given in Table 18.

REGULATORY COMPLIANCE

Air Emissions

In general, the principal standard against which drum reclamation furnaces are evaluated is particulate emissions. The most common way that the limitation is expressed is as grains per dry

TABLE 20. METALS CONCENTRATIONS IN CAUSTIC SLUDGE

Metal	Caustic Sludge (mg/l) Profile Data (1)	Plant A	EP Criteria (mg/l)
Aluminum	-	11.0	-
*Antimony	-	3.77	-
*Arsenic	1.6	0.076	5.0
Barium	651	0.520	100
*Beryllium	-	0.060	-
Boron	-	23.1	-
*Cadmium	9.6	1.16	1.0
Calcium	1,687	50.8	-
*Chromium	199	0.880	5.0
Cobalt	-	0.960	-
*Copper	2,393	0.990	-
Cyanides	10	-	-
Iron	24,922	8.98	-
*Lead	4,554	4.28	5.0
Magnesium	-	21.7	-
Manganese	290	1.21	-
*Mercury	0.48	0.178	0.2
Molybdenum	-	3.41	-
*Nickel	29.2	9.48	-
Phosphorus	7,500	36.7	-
*Selenium	30.5	0.023	1.0
Silicon	5,325	22.9	-
*Silver	2.3	<0.005	5.0
Sodium	8,455	23,400	-
Strontium	-	0.250	-
*Thallium	-	<0.1	-
Tin	-	<0.015	-
Titanium	-	0.230	-
Vanadium	-	1.41	-
*Zinc	6,791	1.44	-

* Priority Pollutant Metals

TABLE 21. ORGANIC COMPOUND CONCENTRATIONS IN SPENT CAUSTIC SLUDGE

Organic Compound	Spent Caustic Sludge Concentration (mg/l)	
	Plant A	Plant B (average)
Acenaphthalene	-	165
Acenaphthalenes, C_1	-	135
Acenaphthalenes, C_2	-	25
Acenaphthene	7.6	-
Aliphatics, C_7-C_{18}	-	12,500
Anthracene/phenanthrene	50	-
Benzenes, C_3-C_4	-	1,625
Bis-(2-ethylhexyl)-Phthalate	-	13
2-chlorophenol	14	-
Chrysene/benzo(a)anthracene	5.4	-
Dicyclohexylamine	59	-
Diethyl phthalate	-	13
Fluoranthrene	5.5	-
Fluorene	12	-
Isopropyl diphenyl amine	17	-
Naphthalene	47	360
Naphthalenes, C_1	-	330
Naphthalenes, C_2	-	335
n-nitrosodiphenylamine	1,200	-
Pyrene	5	-
Silicones	-	4,350

standard cubic foot (gr/dscf). For example, the South Coast Air Quality Management District (SCAQMD) in Los Angeles County uses a particulate standard of 0.08 gr/dscf. A New England state specifies a limit of 0.2 gr/dscf. The standard in Pennsylvania is 0.04 gr/dscf when gas volumes are less than 150,000 dscfm. Hence, drum reclamation furnaces may or may not meet these limitations depending upon their location. Data shows that particulate concentrations were in the 0.12 to 0.16 gr/dscf range. Because the margin between the sampled analyses and standards are close, it is possible that rigorous operational control of furnaces and afterburners may be sufficient to meet relevant regulatory requirements. In the event operational controls are unable to achieve particulate emissions requirements, wet scrubbers may be needed.

Other particulate requirements may be related to opacity measurements or overall emission rates. For example, in Ohio a source may discharge into the ambient air from a stack for not more than six consecutive minutes in any sixty minutes, an air contaminant of a shade not greater than 60% opacity. Opacity readings are taken at 15-second intervals and then averages are calculated for all the six-minute periods. Also in Ohio, particulate emission rates are limited to 0.10 pound per hundred pounds of refuse discharged in incinerators having capacities greater than 100 pounds per hour, or 0.20 pound per hundred pounds for capacities of less than 100 pounds per hour. Both opacity and emission rate standards are less likely to influence emission control methods that the standard defined in terms of grains/dry standard cubic feet.

Drum reclamation furnaces at reconditioning plants have a relatively small influence on overall regional strategies to limit metals and hydrocarbon emissions in air quality control districts. Major attention is likely to be focused elsewhere. However, data show that lead emissions could be a cause for concern. Thus, it may be concluded that the major concern of regulatory agencies will continue to be on particulate emissions rather than metals and hydrocarbons for drum reclamation furnaces.

Vented emissions from painting and drying booths potentially could pose serious air quality problems. The principal source of difficulty is hydrocarbons because some paints contain high percentages of solvents. It has been estimated that larger plants could emit more than 100 tons/year of hydrocarbons. This could be a significant problem for many plants. It appears that the problem may be minimized through use of a series of operational controls which will be described subsequently.

Liquid Waste Streams

There are three options for dealing with liquid streams generated in a drum reconditioning plant: 1) recycle and reuse, 2) treatment and direct discharge, and 3) pretreatment prior to discharge to a publicly owned treatment plant. Only three waste

streams offer potential for treatment and direct discharge: storm runoff, quench water, and leak tester water. These streams will be discussed separately. For caustic washing solutions and rinse water, even after treatment these wastes contain pollutant concentrations which are too high for direct discharge.

The pretreatment option for caustic solutions and rinse water is possible, but more likely for rinse water than caustic solutions. However, even in this case, possibilities could become constrained by increasingly stringent pretreatment requirements. For example, water quality limitations for discharge to publicly owned sewerage systems, as listed in the industry status profile (1), would preclude use of these systems even for the best treatment processes used in the industry.

Thus, it appears that the only viable option for caustic solutions and rinse waters is reuse. This conclusion is consistent with industry practice which tends to be moving rapidly in that direction. However, the major problem evident in preparing caustic solutions and rinse waters for reuse (such as the use of alum addition with dissolved air flotation) is the generation of sludges which potentially could be classified as hazardous. If such is the case, then there is an incentive to reduce sludge volumes as much as possible in order to minimize disposal costs.

Stormwater runoff contaminant concentrations can be minimized by good housekeeping practices, drainage control, and inexpensive treatment methods. A combination of each potentially could permit direct discharge to nearby watercourses.

The liquid fraction of quench water possibly could be treated to meet direct discharge requirements; however, a better approach might be to reduce volumes to a minimum and then mix with rinse water for reuse.

Leak tester water could be treated for direct discharge, but it may be possible to discharge to public sewers without pretreatment because of low contaminant levels and the small volumes involved.

Solid Residues

Reconditioners generally regard the disposal of solid residues as their most pressing environmental problem. Based upon the sampling and analysis program results, and the extensive regulations emanating from the Resource Conservation and Recovery Act (RCRA), this assessment is correct. Both spent caustic sludge and incinerator ash contain appreciable quantities of organic compounds and metals which could present problems related to solid waste disposal.

In an effort to evaluate the possibility of having to treat

reconditioning plant residues as hazardous wastes, a reconditioner had EPA extraction procedure (EP) tests run on four wastes: 1) sludge recovered from caustic washing solutions (mixed sludge); 2) incinerator ash (gray sludge); 3) waste oil from a tight head plant (oil); and 4) abrasive dust from blasting dust collectors (dust). Results for the EP tests are shown in Table 22. Results were below detectible levels for almost all critical parameters. Hence, for selected circumstances it is possible that the solid residues generated at reconditioning plants may not have to be dealt with as hazardous wastes. Implications of these results will be discussed more fully in a later section.

Summary of Environmental Pollutant Pathways

The following list summarizes principal pollutant streams of concern to the drum reconditioning industry, along with probable methods for control:

1) Incinerator particulate emissions - operational controls and/or wet scrubbers

2) Incinerator organic emissions - operational controls and/or wet scrubbers

3) Incinerator metals emissions - operational controls and/or wet scrubbers

4) Painting and drying booths - operational controls

5) Caustic washing solutions - treatment and reuse

6) Rinse water - treatment and reuse

7) Quench water - treatment and reuse or mixing with other liquid streams

8) Stormwater runoff - housekeeping, drainage control, treatment, and direct discharge

9) Leak tester water - discharge to public sewers

10) Incinerator ash - landfill (secured)

11) Caustic sludge - treatment and either incineration or landfill (conventional or secured)

12) Drum drainage - treatment and either incineration or landfill (conventional or secured).

In the subsequent section, specific needs to enable optimization of drum reconditioning processes are enumerated.

TABLE 22. EXTRACTION PROCEDURE (EP) RESULTS FOR SELECTED DRUM RECONDITIONING PLANT WASTE STREAMS

Parameter	Concentration (mg/l) Mixed Sludge	Gray Sludge	Oil	Dust	EP Criteria (mg/l)
Arsenic	<0.1	<0.1	<0.1	<0.1	5.0
Barium	<2.0	<2.0	<2.0	<2.0	100.0
Cadmium	<0.02	<0.02	<0.02	<0.02	1.0
Chromium	<0.05	<0.05	<0.05	<0.05	5.0
Lead	<0.05	<0.05	<0.05	<0.05	5.0
Mercury	<0.004	<0.004	<0.004	<0.004	0.2
Selenium	<0.1	<0.1	<0.1	<0.1	1.0
Silver	<0.1	<0.1	<0.1	<0.1	5.0
Endrin	<0.001	-	-	-	0.02
Lindane	<0.0001	-	-	-	0.4
Methoxychlor	<0.002	-	-	-	10.0
Toxaphene	<0.01	-	-	-	0.5
2,4-D	0.033	-	-	-	10.0
Silvex	<0.002	-	-	-	1.0

SECTION 4

POLLUTION CONTROL NEEDS AND OPTIMIZATION METHODS

This section of the report evaluates pollution control needs of the drum reconditioning industry and recommends methods for upgrading and optimizing current industry practice. Pollutants presently generated are defined by data secured in conjunction with the industry status report (1), and results of the previously summarized sampling and analysis program. Some of the optimization methods are applications of practice presently in use at exemplary plants within the industry. Others are for processes that have been applied in other industries and potentially could be used at reconditioning plants.

GENERAL CONSIDERATIONS

Implementation of regulations promulgated in conjunction with the Resource Conservation and Recovery Act (RCRA) can have a positive impact upon drum reconditioners. If the industry refuses to accept drums that formerly contained materials listed by name in 40 CFR 261.33(e) that have not been triple-rinsed by an appropriate solvent; and if it refuses to accept drums containing residues of hazardous wastes (other than 261.33(e) materials) in quantities greater than 1 inch, then there are several positive outcomes. First, the drums need not be dealt with as hazardous wastes. Second, residues generated during drum processing are less likely to contain materials which could cause these residues to be judged hazardous. Third, caustic solutions and rinse waters will remain cleaner for longer periods. Fourth, overall volumes of residues will be reduced.

Additionally, if reconditioners avoid storing accumulated sludge or containers of hazardous wastes for more than 90 days, and if this sludge or containers are not burned, buried, or treated at the reconditioning site, then it is possible that reconditioners may not require permits under RCRA's hazardous waste regulations, except for generator permits, in the cases of sludge, ash, and oily wastes.

It is recommended that reconditioners refuse to accept drums that are not empty (those containing more than one inch of hazardous residues), unless they are prepared to deal with such

materials effectively. Likewise, it is recommended that drums formerly containing 40 CFR 261.33(e) hazardous wastes to be refused unless they are triple-rinsed. Whether reconditioners store wastes on-site for more than 90 days, or treat, burn, or bury wastes on-site is left to the reconditioner as a business decision.

OPERATIONAL AND MANAGEMENT PROCEDURES

Generation of pollutants and their treatment can be eased through the adoption of certain operational and management procedures. The following discussion identifies such procedures.

Receiving

Drums arrive at reconditioning plants in three different ways: 1) drums can be delivered to the plant by users (usually for laundering as a service); 2) drums can be delivered by brokers who buy the drums from various users; or 3) the reconditioner can pick up the drums at the user's plant. In the first two cases, drums should be inspected by trained personnel as they are unloaded from trucks. The following types of drums should be refused for reconditioning and returned to the user or broker:

- Damaged Drums
- Drums which contain more than one inch of residue unless special provision is made to deal with those materials
- Drums which contain unacceptable materials, i.e. those containing hazardous materials and/or materials which the reconditioners customarily refuse (pesticides, resins, inks, adhesives, etc.)
- Drums without bungs, and rings and lids in-place. (Such drums could be accepted, but reconditioners might charge a fee for placing bungs, rings and lids on the drum).

When drums are picked up by the reconditioners, drivers should inspect the loading of each drum. The drivers should be instructed to refuse the same type of drums described above.

When drums are received at burning plants, either from trucks or storage, those known to create possible smoking problems, e.g. heavy grease, undercoat, or silicone, should be segregated into a separate area. This will permit mixing these drums into normal processing in order to minimize the potential for visible emissions. Such spacing is common at many burning plants.

Storage

All drums going into yard storage should have bungs in-place, and rings and lids on. This greatly reduces the potential for pollution of stormwater runoff. Furthermore, in some cases it may be appropriate for drums having ink or other water-soluble

materials spilled on the outside of the drums to be wiped with an appropriate solvent before being sent into storage. This also will prevent contamination of stormwater runoff.

The storage area should be constructed to minimize the amount of stormwater coming in contact with the drums. Berms and dykes could be used for this purpose. In addition, storage areas could be paved where drums containing pollutants could threaten surface or groundwater.

Because deteriorating drums can be a source of pollution, use of "first-in, first-out" (FIFO) yard inventory methods is suggested. Categorization of drums in storage yards helps in drum recovery, leads to better housekeeping, and aids in minimizing stormwater contamination.

Draining

Because RCRA regulations probably will encourage better emptying of drums, the needs to drain drums before processing will be lessened. In fact, for drums bound for burning, draining probably is unwarranted. It is more desirable to burn drum residues within the reclamation furnace. However, it should be recognized that excess amounts of combustible residue can overload drum furnaces, and furnaces should not be considered as a solid waste incinerator.

On the other hand, draining of empty oil drums is recommended. If a separate oil recovery pit is used, it should be kept clean so that oil can be offered for sale to refiners, or burned as fuel in the reconditioner's furnace.

Draining of other types of drums bound for caustic washing also is desirable. Any residue removed reduces the load on the caustic washing solution and the sludge volumes generated in the caustic. In addition, such drainage has a higher heat value than caustic sludge. This is an important consideration if incinerator disposal is contemplated.

Waste Stream Segregation

It is essential to reuse of caustic solutions and rinse waters that these two waste streams be segregated. Thus, it is recommended that measures be taken to assure that these two streams be kept separate. In this way, subsequent efforts to treat and reuse the various liquid waste streams will be helped. Also, leak tester water should be segregated from other waste streams.

Water Conservation

Currently, on the average about 17.5 gallons of water are

used to process a drum. The target figure for the industry is 10 gallons/drum. By instituting water conservation measures, the volume of liquid waste streams requiring treatment will be reduced. Methods for conserving water include:

- Cascading water use (using water for successive lower quality needs)
- Maintain minimum flows for rinsing, leak testing, cleanup, boilers, and compressor cooling
- Mop up spills rather than flush to floor drains

Some reconditioners have pointed out that water conservation methods should be applied thoughtfully, because concentrating some wastes could make their treatment more difficult.

Housekeeping

In reconditioning plants, good housekeeping is a continual problem. Based upon experience, those plants which pay close attention to housekeeping practices tend to generate less wastes.

Waste Heat Utilization

There are a number of opportunities for reconditioning plants to use waste heat. Some of these are:

- use of heat exchangers to generate steam for plant heating and caustic washing solution heating
- use of waste heat to dry wet drums
- use of waste heat in paint baking ovens
- use of waste heat to preheat drums to assist in draining.

Additionally, it may be possible to burn nonhazardous sludges to generate plant steam. Burning of sludges in the drum reclamation furnace will be discussed later.

PESTICIDE CONTAINER PROCESSING

Data collected in conjunction with this program shows that drums formerly containing pesticides can be processed safely by reconditioners provided that certain precautions are taken. Some of the major precautions are noted below.

- All drums formerly containing pesticides should be triple-rinsed before acceptance.
- When large numbers of pesticide containers are processed, they should be stored in a separate area, and processed together on a campaign basis.
- Reconditioners who are not equipped to process pesticide containers should refuse to accept them.

- Organometallic-type pesticides are not amenable to treatment by either incineration or caustic washing; therefore, containers of such pesticides should be refused in all circumstances.
- Halogen-containing pesticides are best handled by incineration. (Wet scrubbers using NaOH as the scrubbing liquid should be considered for incinerator emission control.) Such containers should be refused at washing plants.
- Only drums formerly containing organophosphorus and nitrogen-containing (carbamates) pesticides should be accepted by washing plants with demonstrated expertise in washing such containers.
- There should be absolutely no pesticide container processing where mixing with drums bound for food use is possible.
- The following management and operational procedures should be employed at plants capable of handling pesticide containers:

    - all pesticide drums should be stored in separate designated areas
    - all pesticide drums should be processed separately from other drums
    - all pesticide drums should be received, transported, and stored with bungs in-place
    - pesticide container processing must be closely supervised
    - employees should be required to wear respiratory masks and protective clothing when handling or processing pesticide drums
    - personnel cleanup should be enforced before breaks, lunch, or leaving the plant area
    - regular health examinations should be performed and safety procedures rigorously enforced.

AIR EMISSIONS

Existing data indicates that typical drum incinerators may or may not meet particulate emission standards depending upon state regulations in force at the plant location. Particulates are the principal air pollutant criterion against which incinerator emissions are measured. Even in cases where state standards are exceeded, normal operation comes close to the particulate standard. Thus, it is concluded that, in many cases, proper operation of drum incinerators and afterburners could satisfy air pollution control requirements. There may be a few exceptions in terms of organic compound and trace metal emissions.

Therefore, specific recommendations for drum burning plants are:

1) Reconditioners should operate plants in accordance with the National Barrel and Drum Association (NABADA)

document, "Drum Reclamation Furnaces:Standards of Design and Operation", December 31, 1979. (3)

2) Incinerator temperatures should be maintained at least at 1200°F.

3) Minimum residence time in the incinerator should be 4 minutes.

4) Afterburner temperatures should be maintained at greater than 1400°F, with a minimum residence time of 0.5 seconds.

5) Afterburners should operate whenever there is danger of particulate or uncombusted organic emissions.

6) In the event that there is danger of higher than normal amounts of combustibles being introduced into the incinerator, the following controls are possible:

   a) varying conveyor speed
   b) varying drum spacing
   c) interspersing drums having large quantities of combustibles with those containing little or no combustibles.

7) Afterburner temperatures for plants burning pesticide containers should be at least 1650°F. Residence times should be a minimum of 0.5 seconds.

8) If particulate and organic emissions exceed air pollution control regulations for normal operation, the afterburner temperatures should be increased to the 1650°F range.

9) If particulates, organics, or trace metal emissions constitute a regulatory problem, then wet scrubbers should be used after the afterburner.

It is believed that adherence to the recommendations above will permit drum incinerators to operate within existing air pollution control standards. Thus, reconditioners should be able to meet air pollution control regulations through careful operations and controls.

Because hydrocarbon emissions from painting and drying booths could be a substantial problem for reconditioners, several operational controls may be implemented to alleviate the problem. Some of these are:

1) increased use of water-based paint
2) use air-dry paints to reduce evolution of hydrocarbons

3) use electrostatic spraying techniques to reduce the amount of paint

4) use high solids paints.

LIQUID WASTE STREAMS

Currently, reconditioners at washing plants are moving toward recycle systems. This is strongly recommended. Reuse of caustic washing solutions and rinse water is most effective when these waste streams are segregated. Thus, reconditioners are urged to separate these streams if that is not current practice. In addition, other liquid waste streams, such as quench water and leak tester water, also should be kept separated from other streams.

Caustic recycle is cost-effective because: 1) it reduces sewer discharge fees and/or neutralization costs, and 2) it reduces caustic purchases.

Provided that stream segregation is practiced, the following methods are recommended for optimized water pollution control in drum reconditioning plants.

Caustic Washing Solutions

In better operated plants which recycle caustic washing solutions, spent caustic is sent to holding tanks where phase separation takes place. In these quiescent tanks, oil and grease and other flotables rise to the liquid surface. Solids settle into a sludge layer at the bottom of the tank. The subnatant (middle zone) contains spent caustic with some solids that have not settled and emulsified oil. This is the liquid that is recycled. Several plants filter this caustic before reuse. The most common filtration method used is diatomaceous earth filters.

Phase separation is the minimum level of treatment recommended before recycle. Some type of filtration for additional solids and emulsified oil removal is desirable, and would extend the life of the caustic solution. Methods for improved handling of the floating and settled phases will be discussed within the section on solid residues.

Rinse Waters

The most effective rinse water treatment systems which prepare the water for reuse currently employ dissolved air flotation with chemical addition (usually alum and polyelectrolytes). Even though this method yields good removals of contaminants, chemical addition causes generation of substantial quantities of sludge.

A literature review conducted in conjunction with the industry status profile (1) showed that ultrafiltration (a membrane process) has promise for treatment of rinse waters. It is recommended that pilot-scale feasibility studies be conducted to evaluate the potential application of this technology for treating rinse waters.

Advantages of using ultrafiltration could be:

1) Production of a clean rinse water capable of extensive recycle

2) Reduction of sludge volumes generated as compared with the dissolved air flotation process with chemical addition

3) Production of a process concentrate (sludge) which possibly could be incinerated easily.

Possible limitations of the process might be:

1) Membranes are limited to a maximum pH of about 13.

2) The optimum rinse water temperature during processing is about 30°C.

3) Prefiltration is necessary to prevent membrane fouling.

Three manufacturers of ultrafiltration equipment offer pilot plant apparatus which could be used to determine process feasibility. These companies are Abcor, Inc., Wilmington, MA; Osmonics, Inc., Hopkins, MN; and Romicon, Inc., Woburn, MA.

It is recommended that such feasibility studies be undertaken at one or more drum washing plants.

Some of the treated rinse water could be used to makeup losses in the caustic solution. By using cleaned rinse water instead of fresh water, overall water requirements could be reduced. In addition, caustic demand also would be reduced.

Quench Water

Quench water volumes can be reduced in several ways. First, quenching can be used only when smoking occurs because of dragout or when higher amounts of combustibles are found in some drums. Otherwise, air cooling should be used, if possible. Second, nozzles which spray quench water should be adjusted so that a fine mist is sprayed. This will reduce the amount of water required.

The source of quench water should be treated rinse water.

In this way some rinse water will be evaporated providing a method to prevent generation of excess volumes of rinse water which might require disposal. That portion of quench water which collects in the ash pit should be sent to the rinse water treatment system for processing.

Leak Tester Water

Data show that leak tester water is low in contaminant concentrations. This water should be able to be discharged directly to a sanitary sewer system.

Stormwater Runoff

Several operational procedures can be employed to minimize the potential contamination of stormwater runoff. Some of these are:

1) Enforce good housekeeping in the drum storage area.

2) Store all drums with bungs and rings and lids in-place.

3) Grade the drum storage area so stormwater runs off and does not accumulate near drums or sludge containers.

4) Do not store drums containing sludges without heads on.

5) Do not place solid residues or sludges on the ground.

6) Store sludges which are not in drums in separate large covered containers.

7) Place berms and dikes around the drum storage area.

In the event that the measures cited above are insufficient in reducing runoff contamination levels to within regulatory standards, then a stormwater holding pond may be contemplated. The holding pond would permit separation of oils and grease and settleable solids. Oil removal using skimmers or belt or rope-type devices should be used before discharge to the receiving watercourse.

SOLID RESIDUES

Methods for and costs of disposing of solid residues from drum reconditioning plants are contingent upon whether or not these residues are judged to be hazardous based upon RCRA regulations. Reconditioners should conduct regular tests on their solid residues to determine which category into which they fall. Based upon existing data and information from individual plants, it is not possible to predict whether sludges will be hazardous

or not. It is highly dependent upon the kinds of drums processed at specific plants.

Regardless of whether the sludges are hazardous, it is becoming increasingly expensive to dispose of solid residues. Thus, a concerted effort should be made to reduce sludge volumes as much as possible.

The following discussion of specific residues focuses on the likelihood that they will be judged hazardous, methods for concentrating residues, and prospective disposal options.

Caustic Sludge

Data from the sampling and analysis program shows that caustic sludge from the one plant having metals analyses has concentrations of materials that would pass the EPA extraction procedure test even if the metals were 100 percent leachable. (The cadmium value was close to the EP test limit, e.g. 1.16 mg/l in the sample vs. 1.0 mg/l for the EP test criteria.) Concentrations reported in the industry profile report (1) were much higher in concentration for almost all metals. Table 22 provides recent EP test results as reported by a reconditioner. All metals for the caustic sludge sample were below detectable limits. Thus, it is possible that caustic sludge may pass the EP toxicity test for metal constituents.

Based on the characteristics of typical caustic sludge, it probably would not be judged as hazardous due to ignitability or reactivity considerations. If sludge pH is less than 12, then the sludge also would pass the corrosivity test as well.

Hence, it is possible that if drums containing 261.33(e) materials are not accepted until they are triple-rinsed; if only empty drums (less than one inch of residue) are processed; and if the ignitability, reactivity, corrosivity, and EP tests are passed, caustic sludge can be classified as nonhazardous. Such wastes could be disposed by conventional methods.

However, Table 21 shows that in spite of these tests and acceptance restrictions, hazardous materials may still appear in sludge. Data on organic compounds shows that several hazardous materials (as defined by Section 261.33(e) of RCRA regulations) appear in the sludge, i.e. bis-(2-ethylhexyl) phthalate, 2-chlorophenol, chrysene, diethyl phthalate, fluoranthrene, and naphthalenes.

It is recommended that reconditioners be aware that even though all other RCRA criteria for determining the hazardous nature of caustic sludges may prove negative, it is possible that specific organics listed as hazardous may be found in the sludge. Because analysis of specific organic compounds is not required

in the EPA methodology for determining whether a waste is hazardous or not, assuming that drums are received "empty"; then, there is some uncertainty as to whether the wastes should be deemed hazardous. It would appear that prudence dictates that reconditioners treat caustic sludge as a hazardous waste until 1) specific organic chemical analysis demonstrates that there are no hazardous constituents, or 2) EPA can resolve with the reconditioners a procedure for dealing with the waste.

For example, a reconditioner could perform all standard RCRA tests on the sludge, with results being negative. Then, the reconditioner could send the "nonhazardous" sludge to an unsecured landfill. Subsequently, regulatory officials could sample the landfill and find organic hazardous materials. If organic hazardous materials are found, EPA could take action against the reconditioners for having improperly disposed of hazardous materials even though all regulations, based upon testing results, were adhered to. Clearly, this issue needs to be resolved.

Regardless of whether caustic sludge is hazardous or not, an attempt should be made to reduce its volume. This can be accomplished in several ways:

1) additional settling or phase separation (with or without chemical addition and pH adjustment)

2) vacuum filtration

3) filter press

4) centrifugation

5) heat treatment (waste heat may be used for this purpose).

Additional settling and phase separation has been used in the past, but there have not been marked improvements in solids content. One reconditioner has successfully employed waste heat to dry caustic sludge. Moisture content ranged from 15 to 45 percent. This same reconditioner recovers oil and other flotables from a caustic holding tank using a rope-type skimmer. Collected material is blended with steam and injected into a drum reclamation furnace as a fuel supplement.

If hazardous caustic sludge is burned at the reconditioner's own drum reclamation furnace, then the furnace is regarded as a hazardous waste treatment facility and must comply with all relevant regulations. On the other hand, if the oily waste is used as a fuel supplement, then the furnace need not be classified as a hazardous waste treatment facility.

The presently recommended approach for caustic sludge disposal is: 1) reduce sludge volume as much as possible through dewatering, 2) recover oily wastes for incineration as a supplemental fuel where feasible, 3) if the sludge is nonhazardous, then ultimately dispose by conventional landfill or incineration, and 4) if the sludge is hazardous, then ship the wastes to a contract hazardous waste management site.

Rinse Water Sludge

Much of the preceding discussion for handling of caustic sludge also applies to rinse water sludge. A concerted effort should be made to determine whether the waste is hazardous or not.

Methods used to treat rinse water sludge and for ultimate disposal depend on how the sludge is generated. If the dissolved air flotation method is used with chemical addition, large sludge volumes having reduced potential for incineration will be evident. If treatment of rinse water using ultrafiltration proves feasible, then lesser sludge volumes will be produced. In addition, there may be options for recovering burnable oily materials. Some of these options are:

1) Mix the ultrafiltration concentrate with tramp oils (recovered free oil) or No. 2 fuel oil and burn directly.

2) Settle the concentrate for 3 to 5 days and burn the oil phase; recycle the water phase to the ultrafiltration unit.

3) Heat the concentrate to 71°C to 82°C (160°F to 180°F) and acidify to pH of 2; the oil phase may be burned and the water phase is neutralized and recycled to the ultrafiltration unit.

4) Use a contract hauler.

Regardless of the rinse water treatment method, an attempt should be made to reduce sludge volumes as much as possible. Similar methods to those specified for caustic sludge could be used. If the sludge proves to be hazardous, then contract hauling of the final concentrated sludge to a hazardous waste management facility is recommended.

Incinerator Ash

Data show that there is a strong possibility that incinerator ash will be classified as a hazardous waste. Settling should be an adequate dewatering technique. Because ash residue volumes tend to be low, it may be appropriate to collect the

sludge in drums or a transportable container. Settling could take place in the container with the liquid fraction being decanted and sent for treatment to the rinse water processing system. The ash then should be sent to a hazardous waste facility.

Drum Drainage

Recovered oil, if kept clean, probably can be sold to a refiner. Other drum drainage should be tested and if hazardous, shipped to a permitted facility. The drainage pit should be covered to minimize the potential for entry of extraneous water. Tests should be conducted to determine whether the drainage is classified as hazardous. If it is, then it should be dealt with much the same as other hazardous residues. If it is nonhazardous, the possibility of burning as a supplemental fuel (maybe mixed with tramp oil) should be explored.

SECTION 5

RESEARCH NEEDS

It was one of the purposes of this report to identify promising processes and procedures which could be used to reduce the pollution potential of drum reconditioning. Some of the methods already are applied in exemplary reconditioning facilities, and thus represent the state-of-the-art. Others require development before they can be used with confidence. Hence, this section is intended to summarize briefly processes and procedures which require additional research. These are listed below:

1) Evaluate whether incinerator particulate, trace metal, and organic emissions can be controlled effectively using operational procedures, e.g. rigorous temperature control, elevated temperatures, variable conveyor speeds, drum spacing, and drum mixing.

2) Develop better filtration systems for preparing caustic washing solutions for reuse.

3) Determine the feasibility of ultrafiltration for use in processing rinse water for reuse.

4) Develop a strategy for cascading water uses (from higher to lower quality needs).

5) Evaluate the potential of good housekeeping and drum storage yard management procedures for minimizing contamination of stormwater runoff.

6) Develop better processes for caustic and rinse water sludge dewatering.

7) Evaluate procedures for disposing of nonhazardous sludges and residues, including oily waste recovery, and sludge burning and drying methods.

REFERENCES

1. Touhill, C.J. Barrel and Drum Reconditioning Industry Status Profile. Contract No. 68-03-2905, U.S. Environmental Protection Agency, Cincinnati, Ohio, February, 1981.

2. Earley, D.E., K.M. Tackett, and T.R. Blackwood. Source Assessment: Rail Tank Car, Tank Truck, and Drum Cleaning - State of the Art. EPA-600/2-78-004g, U.S. Environmental Protection Agency, Cincinnati, Ohio, April, 1978.

3. Krinov, Stanley. Drum Reclamation Furnaces: Standards of Design and Operation. National Barrel and Drum Association, Inc. Washington, DC, December 31, 1973.